DESIGN CONSIDERATIONS FOR COUPLED OSCILLATOR ARRAYS

R. J. Pogorzelski
Mail Stop 138-307
Jet Propulsion Laboratory
Calif. Institute of Technology
4800 Oak Grove Drive
Pasadena, CA 91109

Arrays of electronic oscillators coupled to nearest neighbors can be used to control the aperture phase of a phased array antenna. The linear phase progressions across the aperture necessary to produce steering of the beam may be induced by merely detuning the perimeter (or end) oscillators in the array in an antisymmetric manner. [R. A. York, IEEE Trans., MTT-41, pp.1799-1809][P. Liao and R. A. York, IEEE Trans., MTT-41, pp. 1810-1815] A continuum model of the dynamics of such arrays has been developed in which the aperture phase is governed by a second order partial differential equation of diffusion type. [R. J. Pogorzelski, P. F. Maccarini, and R. A. York, IEEE Trans. MTT-47, 463-470, April 1999.] Also, a number of arrays have been designed, built, and tested; e.g., a seven element linear array [R. J. Pogorzelski, et al, to appear in MTT-47, August 2000.]

Based on the experience outlined above we may conclude that, aside from selection of an appropriate voltage controlled oscillator, the design of such arrays is in essence the design of the coupling network which provides the nearest neighbor coupling between the oscillators. This network must provide the proper coupling strength, coupling phase, and oscillator loading. In addition, the theoretical description of such arrays assumes that the Q of the coupling network be low compared with the oscillator Q. This paper will discuss these constraints in terms of their impact on the network design and will consider analytical methods of relating these important design parameters to the network element values. The network to be considered consists of microstrip transmission lines terminated in resistor networks. Because the oscillators to be considered operate at a parallel resonance, the line lengths must be chosen to provide a total coupling phase of 2π. Deviations in coupling phase from the theoretical ideal cause reduction in locking range and changes in the ensemble frequency of the array. Parallel resistors are used at the ends of the microstrip line to reduce the Q of the network and series resistors are used to control the coupling strength which determines the locking range.